Interactive Control of Avatars Animated with Human Motion Data

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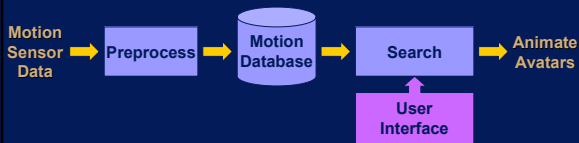
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Avatars: Controllable, Responsive Animated Characters

- Realistic behavior
- Non-trivial environment
- Intuitive user interface

Interactive Avatar Control

- How to create a rich set of behaviors ?
- How to direct avatars ?
- How to animate avatar motion ?

Related Work
(Probabilistic/Statistical Models)

Statistical models
- Bradley & Stuate 97
- Brand & Hertzmann 00
- Pullen & Bregler 00
- Bowden 00
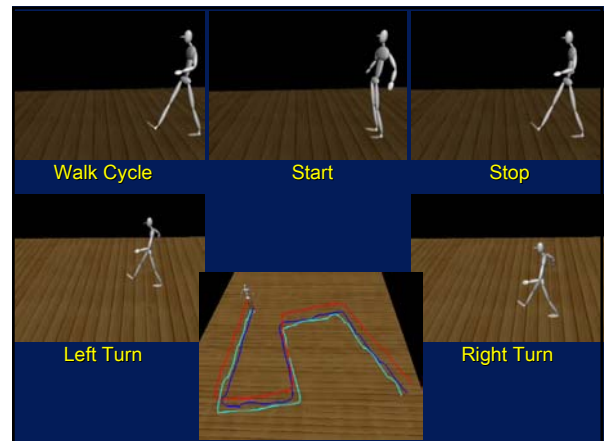- Galata, Johnson & Hogg 01
- Li, Wang & Shum 02

Search and playback original motion data
- Molina-Tanco & Hilton 00
- Pullen & Bregler 02
- Arikan & Forsyth 02
- Kovar, Gleicher & Pighin 02
- This work

Motion Database

In video games
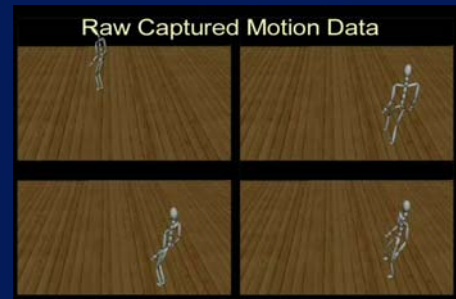- Many short, carefully planned, labeled motion clips
- Manual processing

Walk Cycle   Start   Stop

Left Turn   Right Turn

Motion Database

Our approach
- **Extended, unlabeled sequences**
- **Automatic processing**

Motion Data Acquisition

Raw Captured Motion Data

Maze - Sketch Interface

Re-sequence

Motion capture region   Virtual environment

Sketched path

Obstacles

Re-sequence

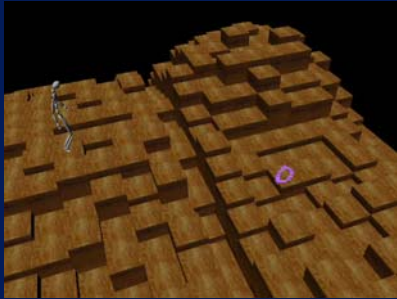Motion capture region   Virtual environment
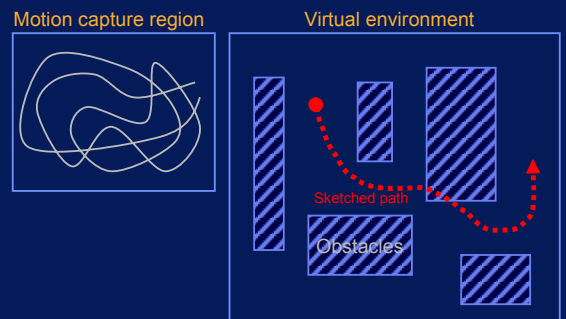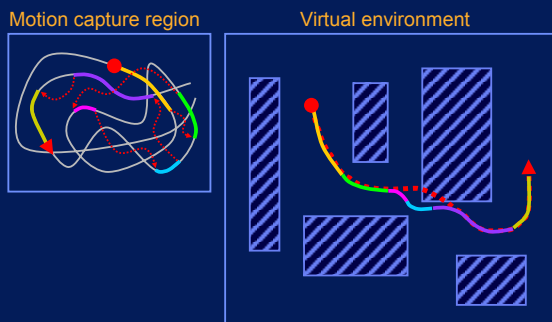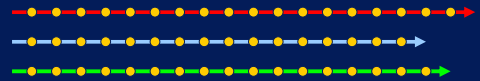
Data Acquisition

"Poles and Holes" rough terrain
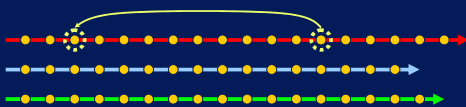
Terrain Navigation

Unstructured Input Data

A number of motion clips
- **Each clip contains many frames**
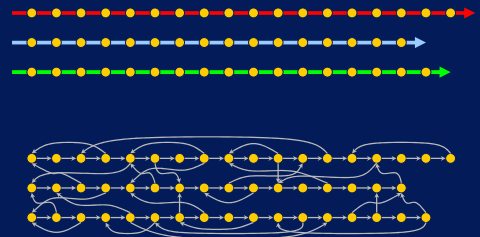- **Each frame represents a pose**

Unstructured Input Data

Connecting transition
- **Between similar frames**

Graph Construction

Distance between Frames

$$D(i, j) = d(p_i, p_j) + \alpha\, d(v_i, v_j)$$

Weighted differences
of joint angles

Weighted differences
of joint velocities
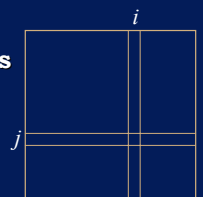

Pruning Transitions

Reduce storage space
- **O(n^2) will be prohibitive**

Better quality
- **Pruning "bad" transitions**

Efficient search
- **Sparse graph**

i

j

Pruning Transition

- **Contact state**: Avoid transition to dissimilar contact state

- **Likelihood**: User-specified threshold

- **Similarity**: Local maxima

- **Avoid dead-ends**: Strongly connected components

Graph Search

Best-first graph traversal
- Path length is bounded
- Fixed number of frames at each frame
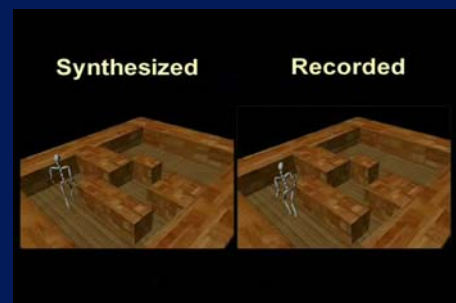
Comparison to global search
- Intended for interactive control
- Not for accurate global planning

Comparison to Real Motion

Environment with physical obstacles

Comparison to Real Motion

Global vs. Local Coordinates

Global, fixed, object-relative coordinates

Local, moving, body-relative coordinates

User Interface

In maze and terrain environments
- Sketch interface was effective

User Interface
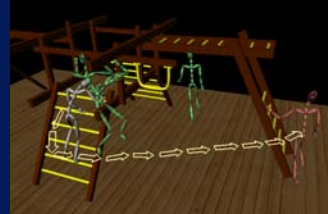
In playground
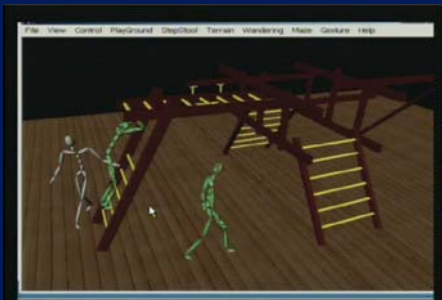- A broader variety of motions are available
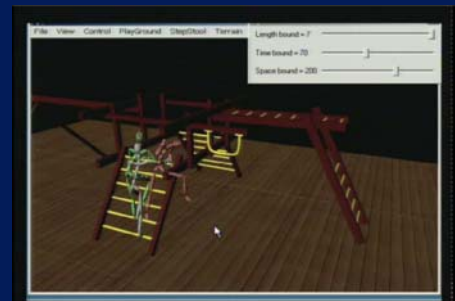

Choice Interface

What is available in database ?
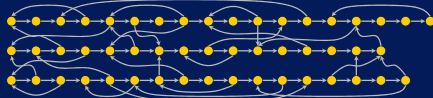- Provide with several options
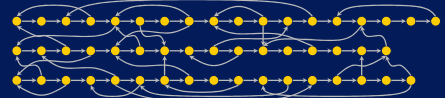- Select among available behaviors

Choice Interface

What to Show
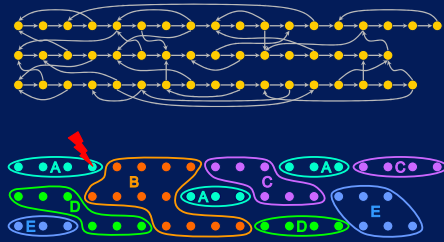### Space and Time Windows

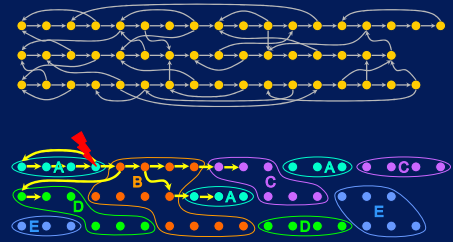## How to Create Choices
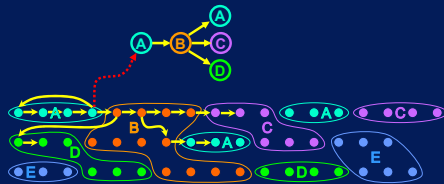

Clustering
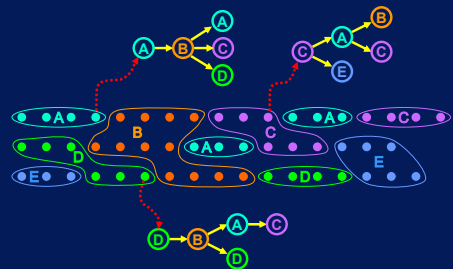
How to Capture Transitions
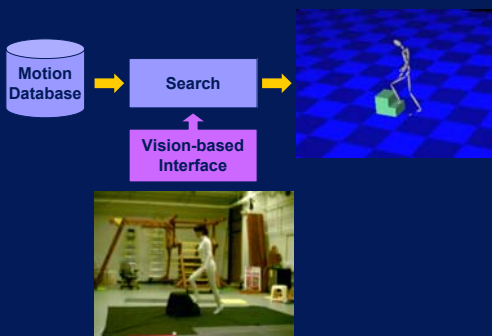

How to Capture Transitions

Cluster Tree

Three possible actions: ABA, ABC, ABD

Cluster Forest

Performance Interface

Vision Interface – Single Camera

Search

Video buffer

3 sec

Search

3 sec
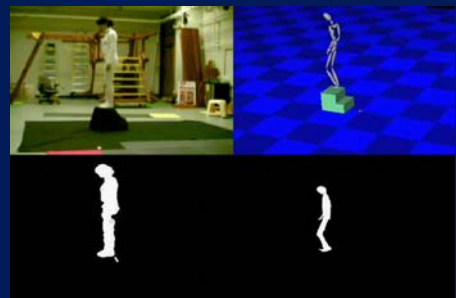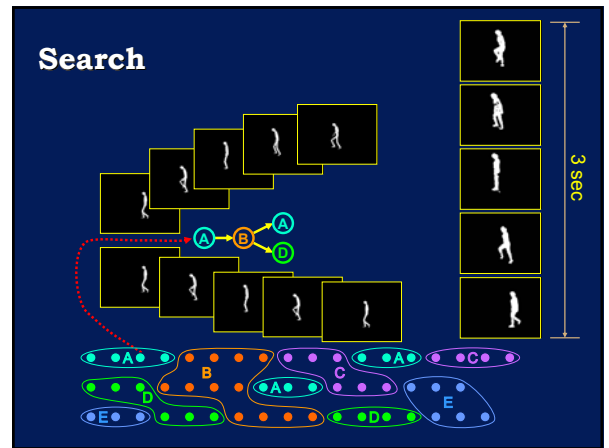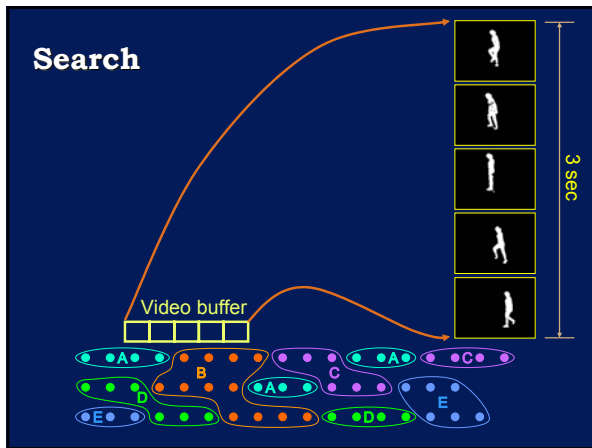
Summary

Graph representation
- Flexibility in motion

Cluster forest
- A map for avatar's behavior

User interfaces

Future Work

Body-relative vs. object-relative
- Assemble objects in new configurations
- Interactions among avatars

Evaluate user interface
- User test for effectiveness

Combine with existing techniques
- Motion editing and style modifications

Acknowledgements

Project web page
http://graphics.snu.ac.kr/~jehee/Avatar/avatar.htm

Similarity between Frames

	Our Work	Arikan & Forsyth	Kovar & Gleicher & Pighin
Joint Angle/Position	Angle	Position	Position
Pose	O	O	O
Velocity	O	O	Implicitly
Acceleration	X	Translation Only	Implicitly

Pruning Transitions

	Our Work	Arikan & Forsyth	Kovar & Gleicher & Pighin
Contact	O	X	X
Likelihood	O	O	O
Similarity	O	X	O
Avoid dead ends	O	X	O

Related Work (Character Animation)

Rule-based	Control system
Bruderlin & Calvert 96 Perlin & Goldberg 96 Chi et al. 00 Cassell et al. 01	Hodgins et al. 95 Wooten and Hodgins 96 Laszlo et al. 96 Faloutsos et al. 01
Example-based	**Probabilistic/Statistical Models**
Popovic & Witkin 95 Bruderlin & Willams 95 Unuma et al. 95 Lamouret & van de Panne 96 Rose et al. 97 Wiley & Hahn 97 Gleicher 97, 98, 01 Sun & Mataxas 01	Bradley & Stuart 97 Pullen & Bregler 00, 02 Tanco & Hilton 00 Brand & Hertzmann 00 Galata & Johnson & Hogg 01 Arikan & Forsyth 02 Kovar & Gleicher & Pighin 02 Li & Wang & Shum 02 **(THIS WORK)**

Related Work (User Interfaces)

Graphical User Interfaces	Performance (Motion capture devices)	Performance (Vision-based)
Bruderlin & Calvert 96 Laszlo et al. 96 Rose et al. 97 Chi et al. 00	Badler et al. 93 Semwal et al. 98 Blumberg 98 Molet et al. 99 "Mocap Boxing" (Konami)	Blumberg & Galyean 95 Brand 99 Rosales et al. 01 Ben-Arie et al. 01